EPECentre
ELECTRIC POWER ENGINEERING CENTRE

UC
UNIVERSITY OF CANTERBURY
Te Whare Wānanga o Waitaha
CHRISTCHURCH NEW ZEALAND

Management of Distributed Generation Using DGHost™ in NZ

Energy Networks

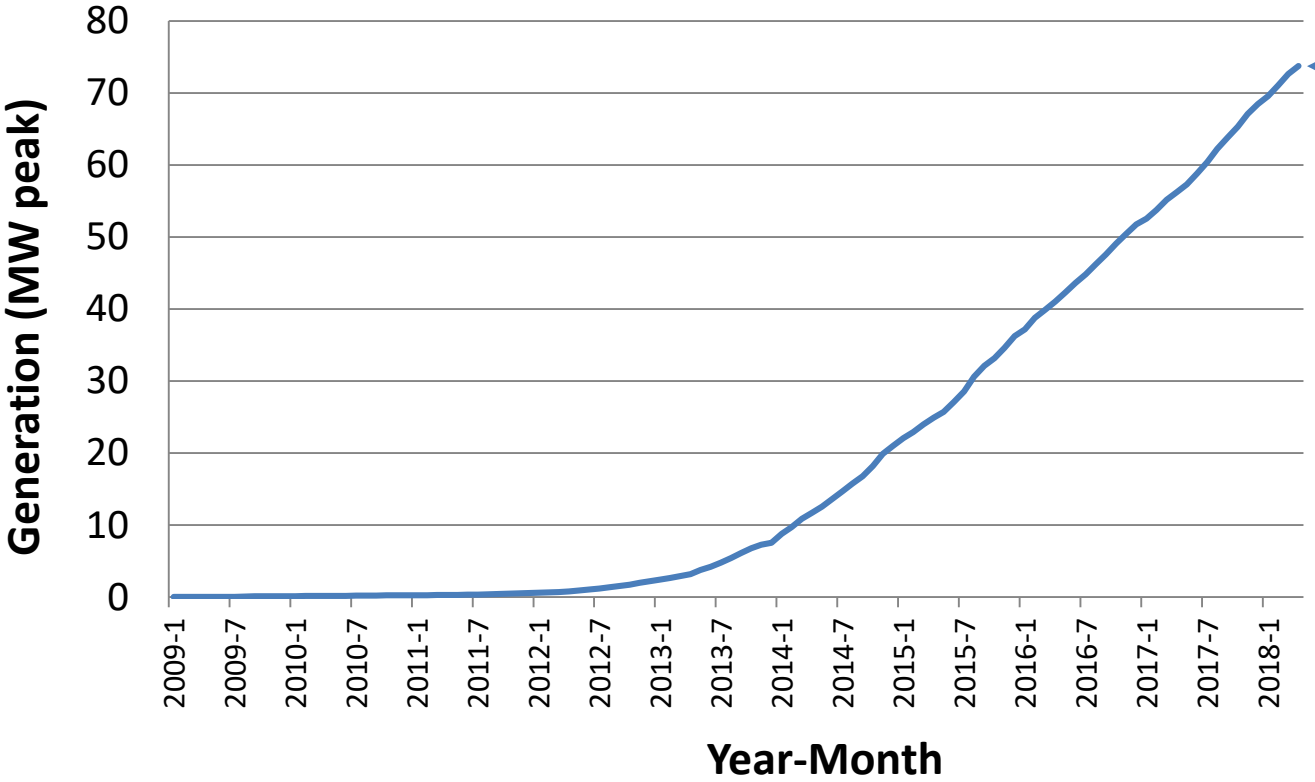
By Sharee McNab, S. Lemon,
T. Crownshaw, R. Strahan, A. Miller

6 June 2018

Outline

- Background
- DGHost™ Method and Tool
- DG Connection Guide
- Where to from here…

PV Uptake in NZ

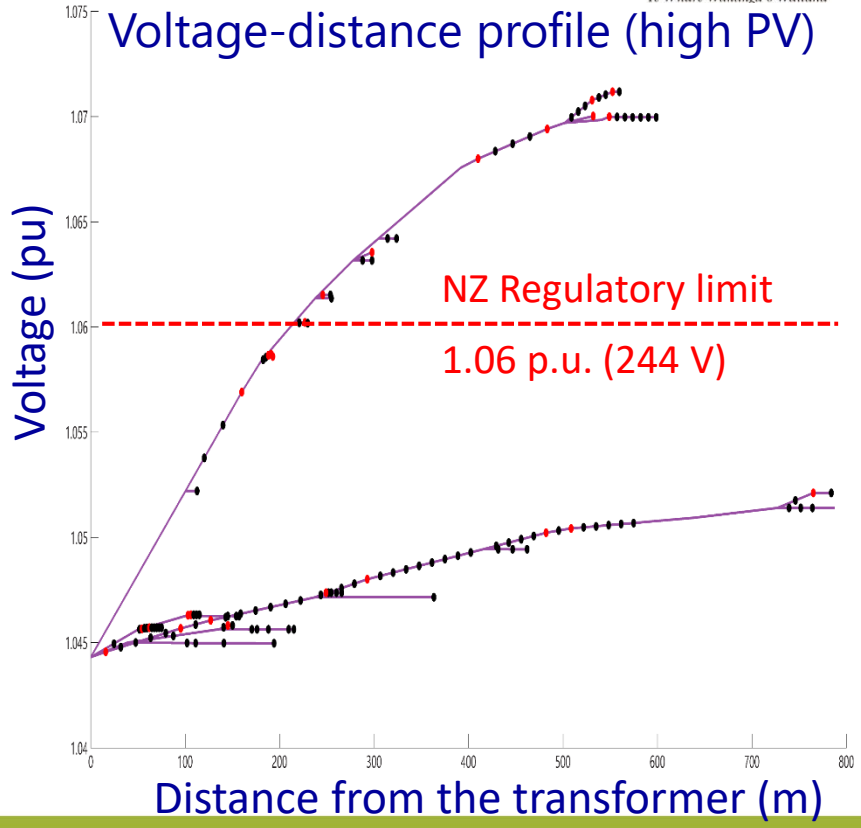


74 MW
30 April 2018

- 100x less PV than Australia
- No PV subsidies

Impact of DG on Distribution Networks

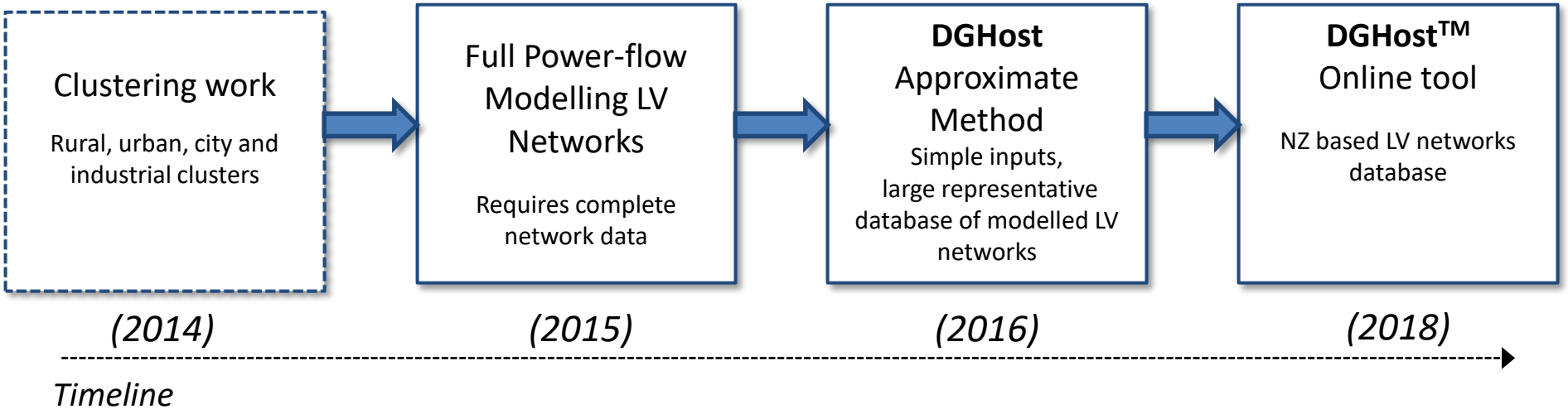
- Congestion
  - Network voltage limits exceeded
  - Equipment current ratings are exceeded



Outline

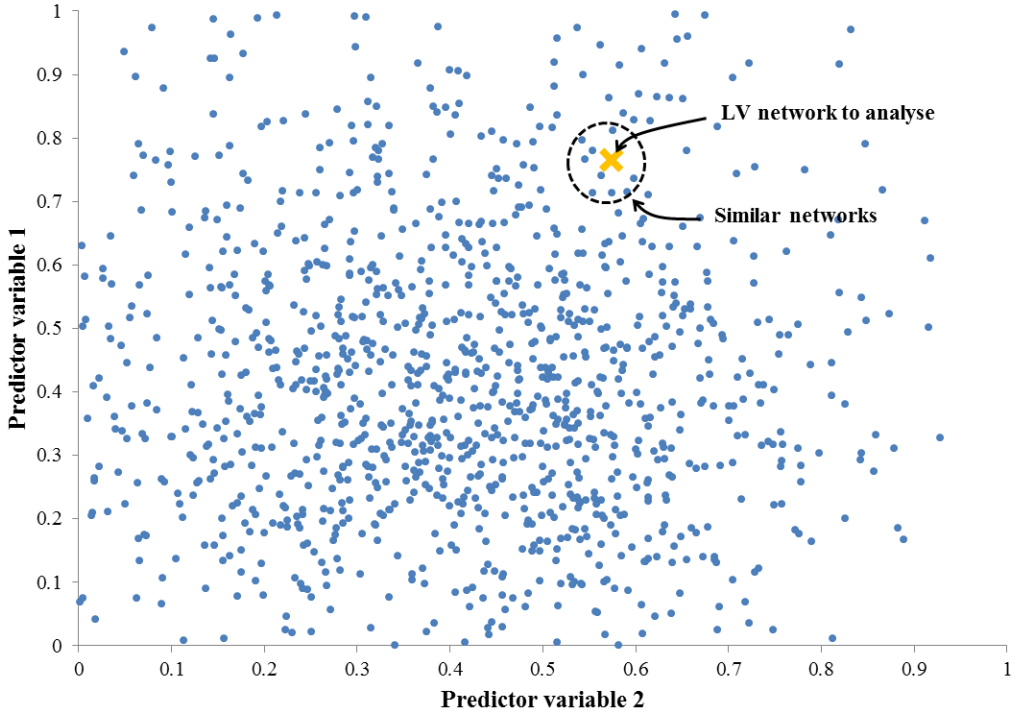
- Background
- DGHost™ Method and Tool
- DG Connection Guide
- Where to from here…

DGHost™ Evolution

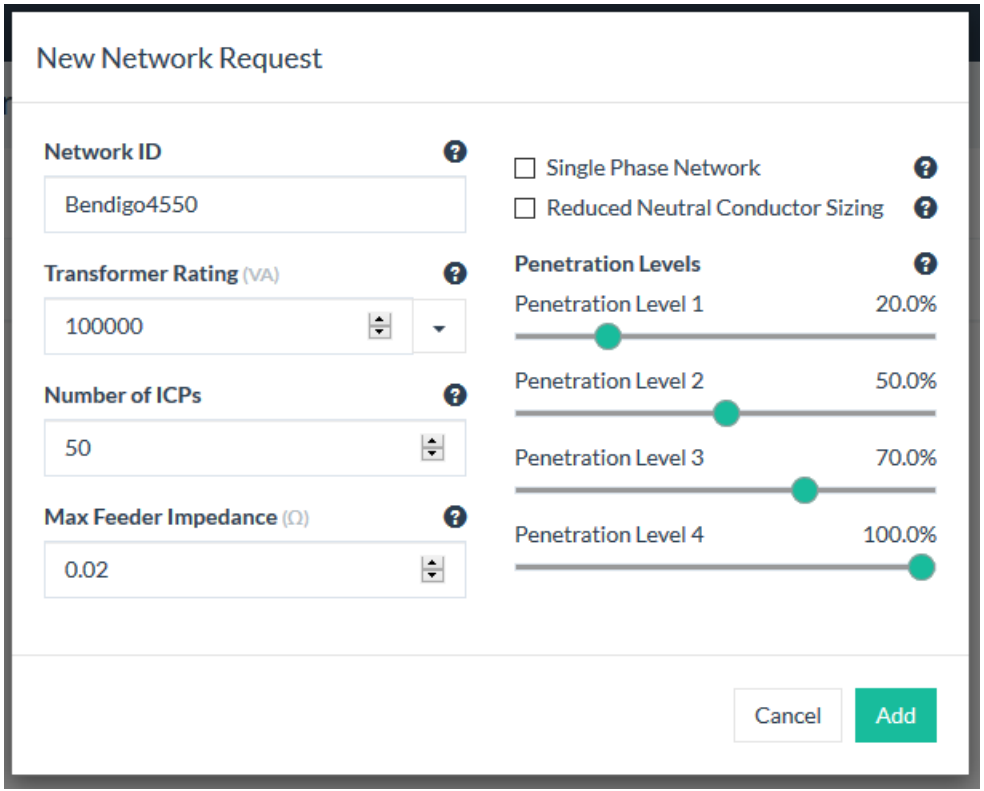


DGHost™ Approximation Method

- Hosting Capacity – maximum export power per DG
- Estimate hosting capacity (HC) of each LV network using the reference data set
  - 20 million HC results
- Optimization of predictor variables
  - As independent as possible
  - Easily determined by Distribution Network Operators
- *k*-Nearest Neighbour Regression



DGHost™ Inputs



Per LV Network

- Transformer Rating
- Number of ICPs
- Max feeder impedance
- Penetration
  - 4 levels
- Network type
  - Single Phase
  - Reduced Neutral

DGHost™ Results

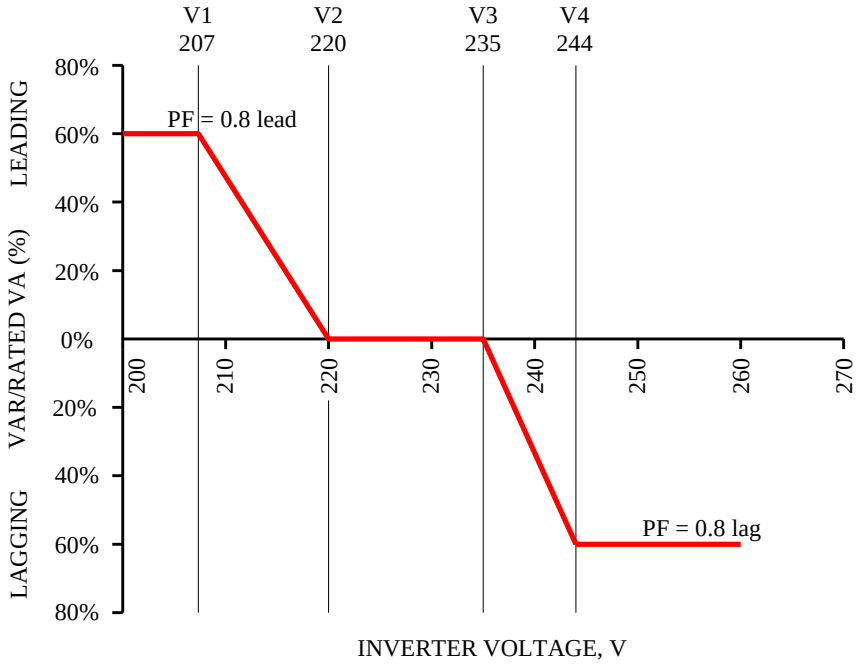
- DG hosting capacity for each LV network provided in an Excel spreadsheet
  - hosting capacities corresponding to each *DG penetration*,
  - Conservative (P25) and Median (P50) hosting capacity per penetration level

	Hosting Capacity Penetration Level 1		
		Conservative	Median
Network ID	Penetration Level [%]	P25 [W]	P50 [W]
Example 1	25	5800	6200
Example 2	28	2000	2300
Example 3	25	4400	4700
Example 4	50	7000	7100

- Models the impact of inverters set with voltage response mode
  (Volt-var settings of 0%, 30%, 60% reactive power)

Impact of Voltage Response Modes

- Inverters with grid supporting features
  - AS/NZ 4777.2:2015
- Voltage response modes
  - Volt-Var: voltages ↑ absorbs reactive power
  - Volt-Watt: voltages ↑ curtailing export



Example Volt-VAr Response (DG Connection Guideline)

EPECentre
ELECTRIC POWER ENGINEERING CENTRE

DGHost Online Tool

www.dghost.nz

Publications on our website

UC UNIVERSITY OF CANTERBURY
Te Whare Wānanga o Waitaha
CHRISTCHURCH NEW ZEALAND

DGHost™ FAQs Contact Sign Up Login

EPECentre ELECTRIC POWER ENGINEERING CENTRE

Power.

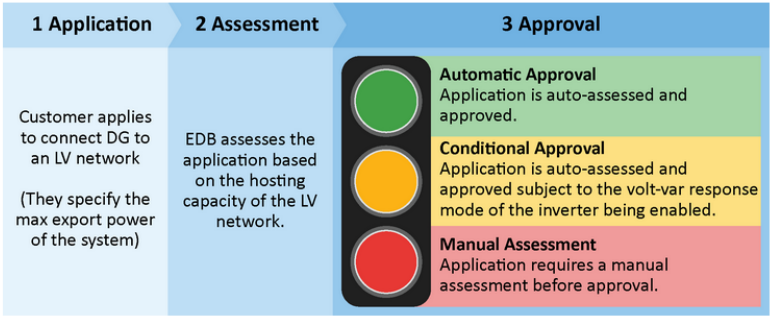
DGHost™

To learn more about the DGHost™ Service, have a look at our DGHost™ Brochure.

Distributed Generation connected on Low Voltage Networks

The connection of Distributed Generation (DG) units, such as solar PV systems, to an electricity distribution network can cause parts of the network to become congested. This congestion is typically the result of voltage rise along feeders or the overloading of equipment in the network. Consequently, when considering DG applications, Electricity Distribution Businesses (EDBs) must be able to determine the maximum amount of DG that can be installed at each ICP in a network, without adversely affecting its operation or breaching network requirements. This amount is defined as the hosting capacity of the network.

DG hosting capacity can be determined by full power-flow simulations of a network, or by approximation methods, such as those used in the DGHost™ Service. The EEA Guideline for the Connection of Small-Scale Inverter Based Distributed Generation *(draft)* specifies appropriate connection requirements for DG applications according to network-specific hosting capacity thresholds. This categorises DG applications into a three-tier traffic light system based on the hosting capacity, as shown in the picture below. Each category reflects the likely impact of the DG exporting into the LV network, and thus if it can be approved for connection.



Three tier traffic light system for assessing DG applications using hosting capacity.

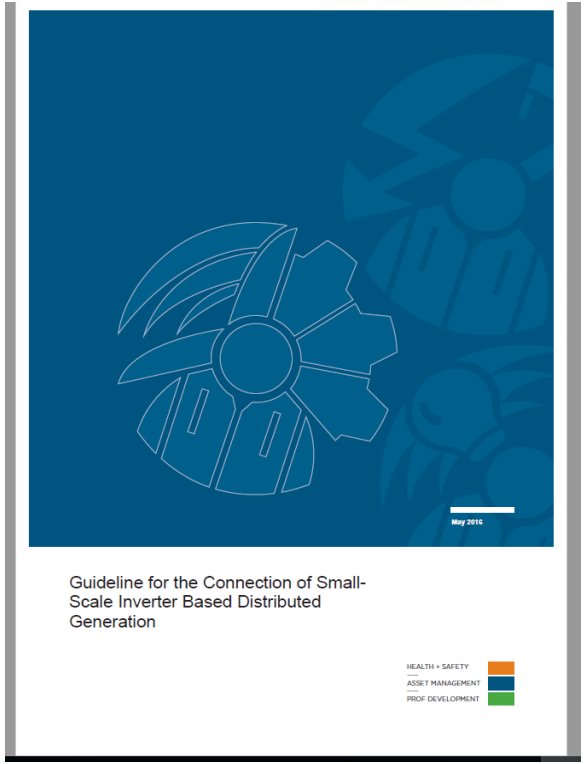
What is DGHost™?

Outline

- Background
- DGHost™ Method and Tool
- DG Connection Guide
- Where to from here…

DG Connection Guide

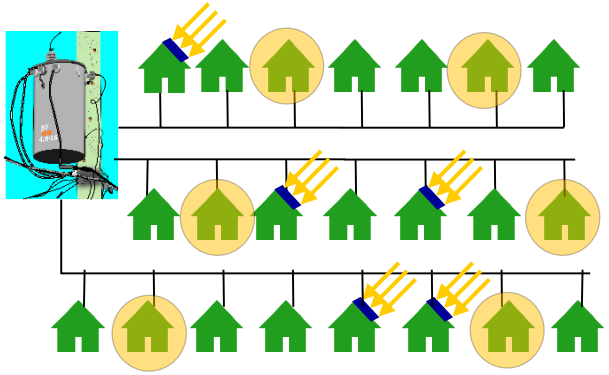
- Provide a consistent approach to DG applications across all DNOs
- Avoid each DNO reinventing the wheel
  - Ensure the important information for each DG application captured
- Streamline the application process by providing an auto-assessment criteria to identify cases which should not adversely affect the network
- Ensure inverter settings were appropriate for the NZ

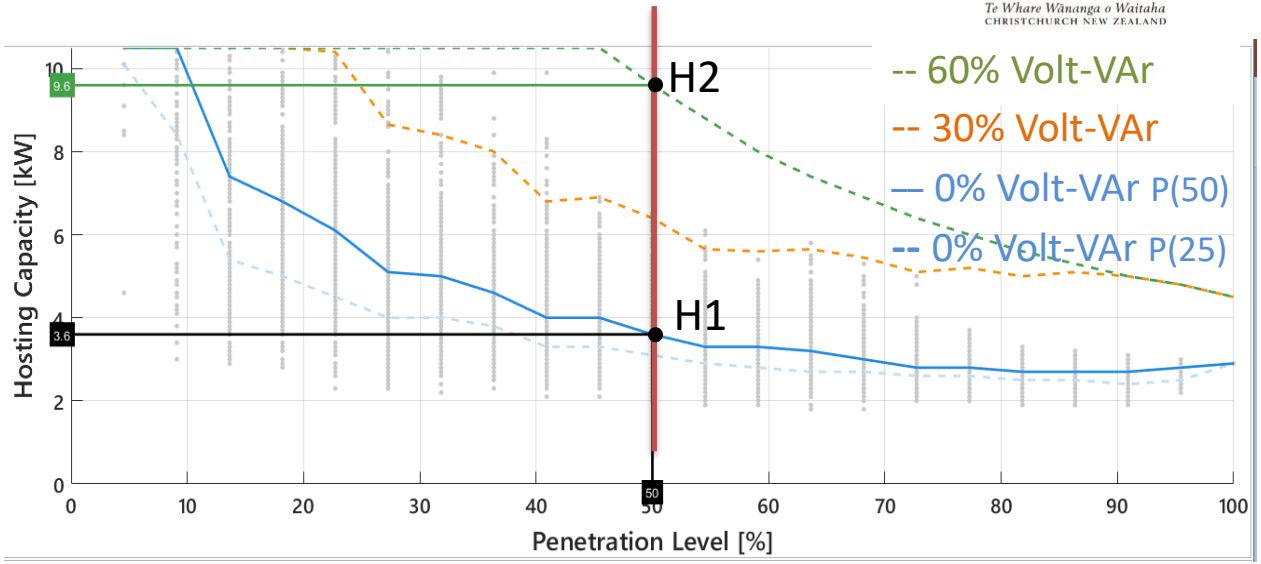


https://www.eea.co.nz/Site/publications/drafts-for-comment/drafts-for-comment-archive/amg-guideline-connection-of-small-scale-.aspx

Example LV Network

DG Penetration: 50% 11DG / 22 ICPs

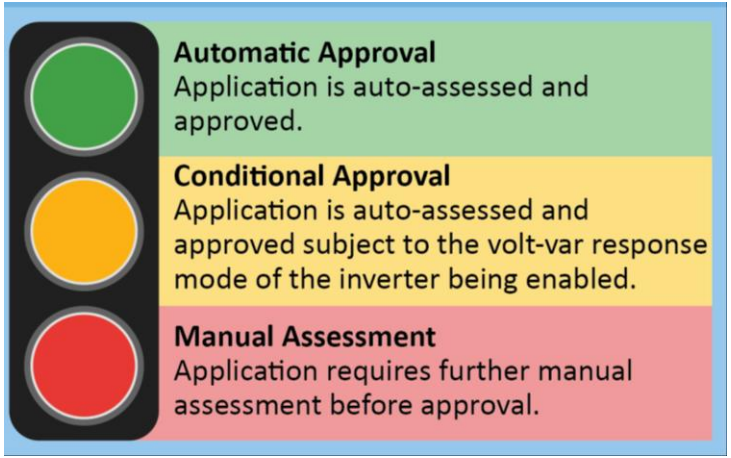




Number of ICPs (N)	22
Transformer Size (kVA)	100
Max Impedance (Ω)	0.18

H1: DG export power threshold, above which mitigation measures are necessary	3.6 kW
H2: DG export power threshold, above which mitigation via inverter volt-var response is insufficient	9.6 kW

Traffic Light Implementation for DG Applications



Application for Export Power
$P < H_1$ (ie < 3.6 kW)

Application for Export Power $H_1 < P < H_2$ (ie between 3.6 and 9.6 kW)

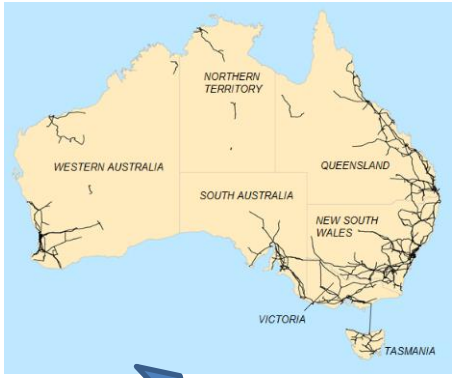
Application for Export Power
$P > H_2$ (ie > 9.6 kW)

Outline

- Background
- DGHost™ Method and Tool
- DG Connection Guide
- Where to from here…

DGHost™ Applicability to Other Territories

- Reassess voltage levels, tolerances, network assumptions
- Build up database of representative networks



Premium Funder

MINISTRY OF BUSINESS, INNOVATION & EMPLOYMENT
HĪKINA WHAKATUTUKI

Co-funders

TRANSPOWER

eea
Electricity Engineers' Association

In-kind Support by

WEL NETWORKS
Best in Service, Best in Safety

meridian

POWERCO

Orion

Mitton ElectroNet

Northpower
"safe, reliable, hassle free service"

networktasman
Your consumer-owned electricity distributor

Marlborough Lines

unison
The Powerlines People

mainpower

Vector

ELECTRICITY AUTHORITY
TE MANA HIKO

Research Lead

EPECentre
ELECTRIC POWER ENGINEERING CENTRE

UC
UNIVERSITY OF CANTERBURY
Te Whare Wānanga o Waitaha
CHRISTCHURCH NEW ZEALAND

Research Partners

UNIVERSITY of OTAGO
Te Whare Wānanga o Otāgo
NEW ZEALAND

Centre for Sustainability
Kā Rakahau o Te Ao Tūroa

Thank you to the supporters of the GREEN Grid programme